MECH ENG 4K03/6K03
Robotics

Undergraduate Studies
Fall 2023/24
Course Outline

CALENDAR/COURSE DESCRIPTION

This course focuses on robotic fundamentals, including forward kinematics, velocities, Jacobians and singularities, inverse kinematics, dynamics, statics, trajectory planning, machine vision, mobile robots, sensors, and actuators, and etc.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in the final level of a Mechanical Engineering program or Mechtronic program.
Antirequisite(s):

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Fengjun Yan
Office: ITB 161
Email: yanfeng@mcmaster.ca
ext. 21525

Office Hours:
Thursday – 1:30pm to 2:20pm

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

Salman Akhtar
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Hamid Razmjooei
razmjooh@mcmaster.ca

For any issues related to assignments, please contact **Salman Akhtar or Zeynab Rokhi**
For any issues related to Midterm Exam, please contact **Hamid Razmjooei or Zeynab Rokhi**
For any other issues, please contact **either of them or Dr. Yan.**

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

http://avenue.mcmaster.ca/

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students should be able to:

1. Interpret and derive the forward kinematics of robot arms.
2. Derive the inverse kinematics of robot arms.
3. Understand, derive and draw singular configurations of robot arms.
4. Derive the dynamics of robot arms.

MATERIALS AND FEES

Required Texts:
N/A

Recommended Additional Texts:
N/A
Calculator:
Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.
Other Materials:

COURSE SCHEDULE

Lecture: Monday & Thursday (12:30pm-1:20pm); Tuesday (1:30pm-2:20pm) in TSH B128
Office hour: Thursday (1:30pm-2:20pm) in ITB 161

Mid-Term 1 (in class): 1:30pm-2:20pm September 26 in TSH B128 (Tentative)
Mid-Term 2 (in class): 1:30pm-2:20pm October 24 in TSH B128 (Tentative)
Mid-Term 3 (in class): 1:30pm-2:20pm November 14 in TSH B128 (Tentative)

Week	Lecture	Topic	In lecture notes
1	1	Introduction	Chapter 1
	2	Introduction	Chapter 1
	3	Introduction	Chapter 1
2	4	Forward Kinematics	Chapter 2
	5	Forward Kinematics	Chapter 2
	6	Forward Kinematics	Chapter 2
3	7	Forward Kinematics	Chapter 2
	8	Forward Kinematics	Chapter 2
	9	Forward Kinematics	Chapter 2
4	10	Forward Kinematics	Chapter 2
	11	Forward Kinematics	Chapter 2
	12	Forward Kinematics	Chapter 2
5	13	Velocities, Jacobians, and Singularities	Chapter 3
	14	Velocities, Jacobians, and Singularities	Chapter 3
	15	Velocities, Jacobians, and Singularities	Chapter 3
6	16	Velocities, Jacobians, and Singularities	Chapter 3
	17	Inverse Kinematics	Chapter 4
	18	Inverse Kinematics	Chapter 4
7	19	Inverse Kinematics	Chapter 4
	20	Dynamics	Chapter 5
	21	Dynamics	Chapter 5
8	22	Dynamics	Chapter 5
	23	Statics	Chapter 6
	24	Statics	Chapter 6
9	25	Statics	Chapter 6

	26	Trajectory Planning	Chapter 7
	27	Trajectory Planning	Chapter 7
10	28	Trajectory Planning	Chapter 7
	29	Machine Vision	Chapter 8
	30	Machine Vision	Chapter 8
11	31	Machine Vision	Chapter 8
	32	Mobile Robot	Chapter 9
	33	Mobile Robot	Chapter 9
12	34	Mobile Robot	Chapter 9
	35	Sensor, actuators, and etc	Chapter 10 &11
	36	Summary and Revision	
13	37	Summary and Revision	

ASSESSMENT

Five assignments will be provided. The full mark for each assignment is 10 points. The average marks of the assignments will count as 10% of the overall score.

Test #1 (in-class)*+: 10%
Test #2 (in-class)*+: 10%
Test #3 (in-class)*+: 10%
Final Exam (2.5 hrs)*: 60%

For 6K03 students, Final Exam will count as 30%, and an additional project will be provided at the mid of the term, which will count as another 30%.

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's grade in the course.

Graduate Attributes	Learning Objectives where it is measured
Knowledge base for Engineering (Indicator 4)	1,2,3,4
Problem Analysis (Indicator 2)	3

For more information on Accreditation, please visit: https://www.engineerscanada.ca

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Mechanical Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the Equity and Inclusion Office.

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the Student Wellness Centre.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy*, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/

The following illustrates only three forms of academic dishonesty:
1. plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. improper collaboration in group work.
3. copying or using unauthorized aids in tests and examinations.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students' responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

1. **Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:**

    - Use the McMaster Student Absence Form (MSAF) on-line self-reporting tool. No further documentation is required.
    - Students may submit requests for relief using the MSAF once per term.
    - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
    - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
    - The MSAF cannot be used for academic work that has already been completed attempted.
    - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
    - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.

2. **For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:**

    - Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
    - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.